PRELIMINARY AND SHORT REPORT

INFLUENCE OF THE DERMAL PAPILLA ON SURVIVAL OF ISOLATED HUMAN SCALP HAIR ROOTS IN AN HETEROLOGOUS HOST*

ROBERT G. CROUNSE, M.D. AND JAMES M. STENGLE, M.D.

The adult human hair is an epidermal structure propagated outward from a bell-shaped proximal tissue mass, the hair root. The dermal papilla consists of a group of cells of mesodermal origin situated within an invagination in the base of the hair root.

Lillie and Wang (1) have shown that growth of the chicken feather is dependent upon the presence of the associated dermal papilla, and that the morphological character of the developing feather may be altered in a predictable manner by specific manipulation of its papilla. The results of tissue culture experiments with embryonic skin suggest that a similar dependent relationship between the dermal papilla and hair exists in the mammal (2).

Investigations of the growth and metabolic requirements of human hair have been impeded by the difficulty in controlling the many variables within the experimental subject. Species differences preclude extrapolation of the results of animal experiments to the human, though patterns of hair growth are generally analagous. Although *in vitro* culture of isolated tissue provides opportunity for control of environmental variables, this technic cannot duplicate the physiological conditions of the tissue in its natural site. The method of heterotransplantation† seems to afford a more physiological environment, as well as an opportunity to alter this environment in a manner possible only in the laboratory animal.

Heterotransplants of human tissue have been accomplished by two general methods. Toolan (3) and Greene (4) have employed as transplantation sites the hamster cheek pouch and the anterior chamber of the guinea pig's eye respectively. Algire *et al*, (5) have shown survival of both Hela cells and a tissue culture line of human epidermis in heterologous hosts using diffusion chambers made of cellulose-derivative (Millipore‡) membranes of graded porosity. Both the hamster cheek pouch and the diffusion chamber method were used by Hambrick and Bloomberg (6) for the transplantation of minced normal embryonic and adult human skin and appendages. However, they did not consider the evidence for epidermal survival in the *chambers* conclusive, nor were observations on the survival of hair roots reported. Sections of the adult human skin removed from the *cheek pouch* of cortisone-treated hamsters contained fragments of epidermis and hair follicles that were considered to be viable on the basis of morphological and staining characteristics. The state of the proliferative portion of the hair root was not mentioned.

It was the purpose of the present study to accomplish heterotransplantation of isolated hair roots from the adult human scalp, and to evaluate the influence of the dermal papilla on the survival of hair roots so transplanted.

All hairs used in this study were in the proliferative (anagen) phase of the growth cycle.

Individual hair roots with papillae included were isolated by microdissection from surgical specimens of normal human scalp. In some hair roots the papilla was then detached by sharp dissection. Since this detachment in addition removed some of the hair root cells adjacent to the papilla, it seemed advisable to use a third group of hairs without papillae in which less of the epidermal hair root tissue was lost. For this purpose hairs were manually extracted from the epidermal surface of the specimen, and from the intact scalp of normal individuals. The roots of such extracted hairs include most of the cells normally surrounding the papillae.

All hair roots were placed in diffusion chambers of the type originated by Algire *et al* (7), constructed with Millipore filter type HA‡ (estimated pore size 0.45 micron) (Fig. 1). The chambers were sealed and placed intraperitoneally in adult C3H brown mice. Ten days later they were removed and placed for 24 hours in Cajal's uranium nitrate-alcohol-formalin fixative. Following infiltration with paraffin the hairs and filter membrane were cut *en bloc* from the supporting plastic rings of the chambers, and embedded. Transverse serial sections, 4–6 μ in thickness, were cut through the entire length of the hair roots and stained with the Gomori trichrome technic.

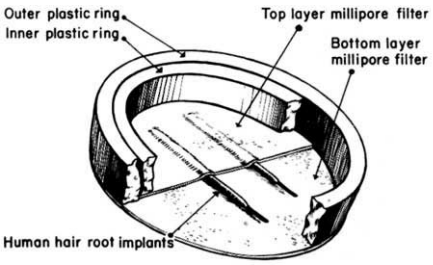
Received for publication December 6, 1958.
The authors wish to thank Dr. Eugene J. Van Scott for his valuable aid in preparing this paper.

* From the National Cancer Institute, National Institutes of Health, Bethesda 14, Md.

† The word heterotransplant is used to signify the technic of transferring tissue from an individual of one species to one of another species.

‡ Obtainable from Millipore Filter Company, Watertown, Mass.

A total of ten chambers were implanted in successive experiments, each chamber containing two or more hairs with papillae intact and two or more with papillae detached. Histological examination of the specimens showed that sixteen of the twenty-eight hairs implanted with the papillae intact had normal cellular architecture, normal nuclear and cytoplasmic staining characteristics, and mitoses at all levels of the hair root (Table 1.). By contrast, all twenty hairs implanted without papillae were found to have lost all cellular detail, with destruction of nuclei and cell walls (Fig. 2).



SCHEMATIC CROSS-SECTIONAL REPRESENTATION OF DIFFUSION CHAMBER ASSEMBLED WITH HAIR IMPLANTS

FIG. 1

TABLE 1

	Number Implanted	Number Surviving
Hairs with Papilla	28	16
Hairs without Papilla	20	0

Several hairs from which the papillae were detached by sharp dissection were implanted with the detached papillae left immediately adjacent to the hair root. None of these roots survived. This result does not explain the dependent relationship that exists between the hair root and the dermal papilla. Factors of physical continuity and diffusion which may influence this relationship require further investigation.

Isolated hair roots from the adult human scalp therefore may be successfully maintained in an heterologous host for at least ten days by means of a diffusion chamber method. Their survival however, appears to depend upon the presence of an intact dermal papilla.

The occurrence of normal growth of the transplanted hairs has not been proven. If under these experimental conditions normal growth can take place, the technic may offer an excellent opportunity for further studies of intermediate metabolism and keratin synthesis in human hair.

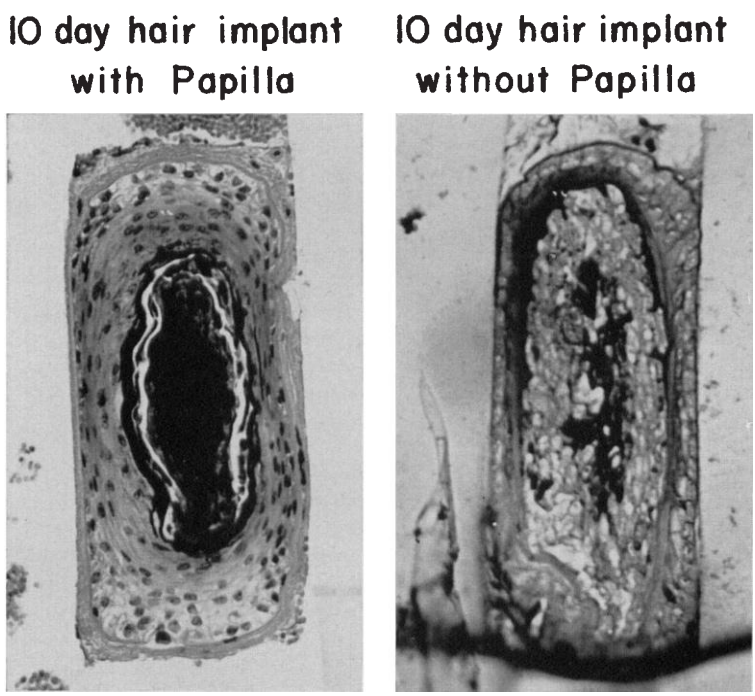


FIG. 2. Tabulation of results and photomicrographs of hair root heterotransplants.

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